Foreign Animal Disease Report

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In This Issue

Current Events

Exotic Newcastle Disease in Pet Birds

On April 1, 1987, exotic Newcastle disease was confirmed in two pet-bird dealer facilities in Maryland and New York. Domestic poultry were not involved in the outbreak and none were found to be exposed to the infection up to the time this issue of the Foreign Animal Disease (FAD) Report went to press. Laboratory test results showed the presence of exotic Newcastle disease in young yellow-naped Amazon parrots that died at the affected establishments. State quarantines were placed on the two facilities, Docktor Pet Center in Hunt Valley, Md., and Joan's Exotic Birds in Schenectady, N.Y. At the Maryland site, the disease was confirmed in six birds purchased through a Louisiana bird dealer. All of the birds were destroyed to prevent the disease from spreading. At the New York establishment, the disease was confirmed in one of two birds purchased from a California supplier. State and USDA officials traced the disease outbreak, which is believed to have originated in southern California. Tracing and testing activities have been or are being conducted in the 17 States where exposed or possibly exposed birds were shipped. Owners were paid indemnities by USDA for birds that had to be destroyed to prevent spread of the disease.

Exotic Newcastle disease can cause death rates from 50 to 95 percent in infected chicken flocks. The disease poses no health risk to people who eat poultry or eggs. In rare cases, individuals who handle infected birds can contract the virus, which in humans causes a transitory eye inflammation and mild flu-like symptoms.

The most serious U.S. outbreak of exotic Newcastle disease occurred in 1971-73 in southern California, where the disease spread from infected pet birds to a dense poultry population. Nearly 12 million birds--mostly laying hens--were destroyed at a cost of $56 million. (USDA News Division, Office of Information, 301 436-7799.)

Sheep Arthrogryposis and Hydranencephaly

An outbreak of arthrogryposis-hydranencephaly complex (AGH) was observed in newborn lambs from flocks located at the Texas A&M University Research and Extension Center at San Angelo, Texas. The same condition was observed in the Angelo State University (A.S.U.) flock located in an adjacent pasture. On January 5, 1987, 4 days before the calculated lambing date, two lambs with the AGH syndrome and one mummified fetus were born to two ewes. These were the first lambs born during the current lambing season. The next day, four lambs with the AGH syndrome were delivered from two other ewes. The typical appearance of the AGH affected lambs included poor muscular development, particularly of the limbs and rib cage, scoliosis, cerebellar hypoplasia, micromyelia, hydranencephaly, arthrogryposis, and brachygnathia. Many AGH lambs were too weak at birth to maintain vital functions without maternal support and would usually gasp and die quickly.

The first ewes having AGH lambs were descendents from highly fertile Booroola rams imported from New Zealand in 1984-85. Therefore, the possibility of foreign disease agents such as **Akabane** virus was considered early in the investigation of this AGH outbreak. Other causes considered included a poisonous plant (Solanum dimidiatum), mineral toxicity, border disease virus, bluetongue virus, and Cache Valley virus (CVV). Akabane virus is a cause of AGH in ruminants in Australia, Japan, Israel, and the far eastern countries. The clinical signs and gross lesions seen in the 1987 outbreak were identical to those reported for Akabane disease (Parsonson, I.M. et al., Vet Microbiol. 209, 1981). Therefore, blood serum samples from four Booroola crossbred rams, three ewes which had AGH lambs, and one fetus with AGH syndrome, were tested for Akabane viral antibodies at the U.S. Department of Agriculture Foreign Animal Disease Diagnostic Laboratory. A sample from a Booroola crossbred ram was found positive, resulting in the placement of a quarantine on both flocks. The original eight sheep, all rams in both flocks, all dams of AGH lambs, precolostral serum samples from AGH lambs, and dams of normal lambs were then tested. Again, only the one Booroola crossbred ram was serologically positive for Akabane. All attempts to isolate virus from fetal and maternal tissues were unsuccessful. Antibodies against bluetongue virus and border disease virus were not detected in precolostral serum samples from lambs affected with AGH. However, the identification of CVV antibodies in 29 dams of lambs with AGH suggested an in utero infection (Shope personal communication). Antibodies to CVV were also demonstrated in some ewes with normal lambs. Precolostral serum samples from AGH-affected lambs were seropositive for CVV (Chung personal communication). On the basis of these serological results, CVV was considered as a possible cause of this outbreak.

History of Cache Valley Virus: CVV was first isolated from a collection of mosquitoes (Culiseta inornata) trapped by Shope in Cache Valley, Utah in 1956 (Holden and Hess, Science 125:1187, 1959). CVV was isolated from the brain of a sick caribou in Wisconsin in 1970 (Hoff et al., J. Wildlife Dis., 6:483, 1970) and from an apparently normal horse in Michigan in 1980. The

first isolations of CVV in 1981 in Texas were from a sick ram at Mertzon near San Angelo and a cow from a herd having severe reproductive problems at Texarkana (McConnell et al., Vet. Microbiol. 13:11, 1987). Serum samples obtained from white-tailed deer in South Texas in 1963, 1969, and 1970 contained CVV antibodies (Issel et al., J. Wildlife Dis. 6:479, 1970). In a survey conducted in Texas in 1981, serum samples were collected from 366 young ram lambs (5 to 9 months of age) representing 50 flocks; 19.1 percent were seropositive for CVV. Ram lambs from Colorado, Kansas, and Wyoming were included in this survey. Serum samples seropositive to CVV were obtained from rams from each State. Ten percent of the lambs surveyed in the spring of 1986 in the two involved flocks were seropositive for CVV, suggesting that CVV-susceptible sheep would be present at breeding season (August-September) in 1986 (Chung, MS Thesis, Angelo State Univ., 1986).

Experimental inoculation studies using the Texas isolate of CVV were conducted at San Angelo. Experimentally infected adult sheep remained normal. The virus was recovered from a ewe with a slight febrile reaction. All of the adult ewes seroconverted by post-inoculation (p.i.) day 8. Experimentally infected gnotobiotic lambs developed a viremia, demonstrated a slight febrile reaction on p.i. day 5, and seroconverted. Nervous signs developed in most gnotobiotes after p.i. day 18, including transient head tremors and epileptiform convulsions. No lesions were observed in the gnotobiotes at necropsy (McConnell et al., Vet. Microbiol. 13:11, 1987). Sheep in early pregnancy have not yet been experimentally inoculated with CVV.

Summary. An outbreak of AGH involving newborn lambs occurred in two adjacent flocks at San Angelo, Texas. The loss of lambs attributed to AGH was 18.6 percent (68 of 366) in the Texas A&M flock and 3.5 percent (11 of 313) in the ASU flock. A tentative diagnosis of CVV as the causative agent in this outbreak of AGH is based on serology. Attempts to recover virus from diseased animals were not successful and experimental reproduction of the disease syndrome has not been completed. Cache Valley virus was isolated from a sick ram near San Angelo and a cow in Texarkana. Cache Valley virus is capable of producing a mild febrile reaction with viremia and seroconversion in adult sheep. Viremia, a slight febrile reaction, seroconversion, and central nervous signs were experimentally produced in gnotobiotic sheep. In order to be certain that CVV is the etiologic agent in this AGH outbreak, susceptible pregnant sheep must be experimentally inoculated with the CVV and lesions typical of AGH must appear. Also, CVV must be recovered from the affected fetus. These experiments will be completed this summer at San Angelo. (C. W. Livingston, Jr., Texas Agricultural Experiment Station, San Angelo, Texas, telephone 915 653-4576; R. A. Crandell, Texas Veterinary Medical Diagnostic Laboratory, College Station, Texas; E. Collisson, Department of Veterinary Microbiology & Parasitology, Texas A&M University; and J. Edwards, Department of Veterinary Pathology, Texas A&M University.)

Llama Imports

In the past few years, the Department has received many requests to import llamas and other Camelids from South America into the United States.

Many areas in South America are now restricted because of foot-and-mouth disease. Therefore, animals imported from these countries must come through the U.S. Department of Agriculture's Harry S Truman Animal Import Center (HSTAIC) after being qualified and quarantined for 75 days in the country of origin.

Animals may be imported through the HSTAIC after being approved through a lottery system to be assembled with others in a multiple ownership group, or through selection of an application for exclusive use of HSTAIC. Exclusive use must be requested by way of an application submitted to the Department. Applications are considered in the order in which they are received. They are valid only through the fiscal year in which they are requested.

In October 1986, the Department received 23 applications requesting exclusive use for fiscal year 1987. Because of the testing and quarantine time required, only one or two projects are possible each year. There is a possibility that in August the first application received for fiscal year 1987 may be accepted. All other applications will expire on September 30, 1987, and the process will begin again.

The Department is now in the process of completing an importation project that started during fiscal year 1986. Two Veterinary Medical Officers (VMO) and two Animal Health Technicians (AHT) were sent to La Paz, Bolivia, to inspect 224 Camelids for possible importation into the United States through HSTAIC. The animals were brought into an isolation area in La Paz and separated into three groups. Blood and oesophageal-pharyngeal fluid samples were taken and sent to the Foreign Animal Disease Diagnostic Laboratory (FADDL) where they were tested for foot-and-mouth disease, bluetongue, brucellosis, trypanosomiasis (Trypanosoma vivax), and vesicular stomatitis. All samples were found to be negative: There was no evidence of the diseases for which they were tested. The animals were also tested for tuberculosis and certified by the official veterinarian in Bolivia and a U.S. Department of Agriculture (USDA) veterinarian, that they had been inspected and found to be healthy and had not been exposed to any infectious or contagious diseases. At the time this article was written, the animals were in the process of being brought into an approved quarantine station in La Paz for 30 days, where the series of tests was to be repeated. If the test results are negative, the animals will be transported to the HSTAIC, where they will be retested using procedures similar to those used on the farm of origin. Animal inoculation tests will also be conducted in sentinel cattle and swine. One sentinel will be inoculated with specimens collected from eight llamas. After completing a 90-day quarantine at the facility, with negative results of all tests, the llamas will be released to the importer. (M. Burke and D. E. Herrick, 301 436-8530).

Asian Foot-and-Mouth Disease Outlook

(Note: the following article by P. G. Joseph, Veterinary Research Institute, Ipoh, Malaysia, titled "Foot-and-Mouth Disease in Asia during the Nineties," appeared in the December 1986 issue of Asian Livestock.)

In the last decade foot-and-mouth disease (FMD) and its control in Asia had received a great deal of attention. There were a number of reasons for this. The advent of major livestock improvement programmes, especially in the dairy sector, and an appreciation of the economic benefits to be gained from international trading in livestock and livestock products, has brought about a much greater awareness of the need to initiate programmes in the control of the disease. The increasing demand in some countries for animal products such as meat and the availability of modern methods of transportation of domestic animals and products has seen the rapid spread of the disease from one region to another. Peninsular Malaysia and Singapore which were free from the disease for more than 30 years were suddenly among the infected countries in 1973. These incidents underscored the urgent need for a regional or at least an intercountry approach to the control of FMD. In addition there was increasing international collaboration and assistance in the region to bring the disease under control. Thus we saw Indonesia embarking on an eradication programme in 1975 with Australian assistance. Similarly, Thailand has received FAO and Japanese aid in the establishment and improvement of the vaccine production centre at Nong Sarai. International collaboration in India, Nepal, Burma, and Sri Lanka has also resulted in the setting up of vaccine production facilities or laboratories for FMD diagnosis.

However, this increased activity in FMD control in Asia was not being co-ordinated or even looked at from a regional viewpoint until APHCA came into the picture. The third session of APHCA in Bangkok in July 1978 supported the proposal for the control and eradication of FMD in the ASEAN countries and considered that the experience of Indonesia might serve as a model for other ASEAN countries. Consequently APHCA sponsored a workshop on FMD control in these countries in Kuala Lumpur in April 1979. The seventh APHCA session in Surabaya, Indonesia constituted a Working Group on FMD and its first task was to undertake a comprehensive report on the FMD situation in the Asia-Pacific Region. This report (FAO/APHCA Publication No. 4) published in 1984, for the first time, placed on record the current status of FMD in the 14 APHCA member countries and 9 neighbouring countries. Of these 23 countries, seven, namely Australia, Brunei, Japan, Republic of Korea, Mauritius, Papua New Guinea, and Singapore, were free from FMD in 1983. Countries in Asia and Oceania not included in the above report and free of FMD then, were Israel, Korea DPR, New Zealand, and all the other territories and islands in the Western Pacific. China, Mongolia, Macau, and Maldives are also believed to have been free of the disease.

What progress has been made since the publication of the FAO/APHCA Report on FMD Control in Asia-Pacific Region? What

progress can be expected for the nineties? The answers to these and similar questions can only be gauged on the basis of the current disease and control status in the region as well as developments elsewhere.

Since 1983, the significant achievement is the successful control of the July 1983 FMD outbreak in Java, Indonesia. By December 1983, the disease was brought under control with no clinical cases being reported since then. Vaccination of the entire susceptible livestock in Java would end this year and the country will officially seek freedom from the disease status.

The Indonesian experience can be expected to be repeated in Sri Lanka, an island State with well demarcated FMD areas and free areas. Presently, an APHCA funded feasibility study is in progress to assess the possibility of eradicating the disease from the country (Siriwardene, 1986). In the 1984 FAO/APHCA Report, Sri Lanka, the Philippines, Malaysia, and Indonesia were considered countries that could embark on eradication programmes. With Indonesia now on the verge of declaring itself free and Sri Lanka expected to go into an eradication programme, the progress so far made is significant. In the nineties, the Philippines and Malaysia should be embarking on eradication programmes.

In India and Thailand present efforts to create disease-free zones (DFZ) are expected to continue. In Thailand the disease control and eradication procedures in southern provinces, covering regions 8 and 9 and the southern half of region 7, should see the re-establishment of the DFZ which is so essential for the eradication of FMD in Peninsular Malaysia. The introduction in June 1985 of Asia-1 FMD outbreak in the northern border State of Kelantan and subsequently to the adjoining State of Trengganu has resulted in a revaccination campaign in Peninsular Malaysia with a bivalent (O and Asia-1) vaccine. The bilateral (Thailand and Malaysia) control programmes in the nineties should see the declaration of Southern Thailand as a DFZ and Malaysia free of the disease.

In India, in the pilot project in the Nilgiris district, through regular vaccination of all susceptible livestock twice a year, the incidence of the disease was reduced from 69 outbreaks with 14,972 animals affected in 1981 to 4 outbreaks and 17 animals affected in 1984 (Srinivasan, 1985) The success achieved in this pilot project has helped to extend the area of operation. The Indian Dairy Corporation has initiated a scheme under Operation Flood II for the control of FMD in 23 other districts in three States in Southern India. In addition, the Government of India initiated a compulsory, free vaccination programme in two districts of Kerela State and one district of Tamil Nadu State in 1983 with the collaboration of the two State governments. This programme is to be extended in the nineties to consolidate the DFZ being created in the south.

Much progress in the control of the disease has been achieved. There is, however, the impending risk of the spread of SAT-1 virus eastward from Yemen where outbreaks of FMD due to this

virus type have been reported in 1984 and 1985. The previous outbreak of SAT-1 in Asia in Iran in 1962 was effectively controlled in 1964. It will be in the interest of all countries in Asia, especially those neighbouring Yemen, to ensure that this virus type does not spread into their countries.

In countries where there is currently no nation-wide strategy for the control of the disease, the improvement of livestock and the increasing possibility of livestock trade in the nineties would act as a leverage for governments to commit themselves to the control of this disease. The examples of neighbouring countries and the increasing regional and international collaboration that will be available should act as stimulants.

The Indian Veterinary Research Institute at Bangalore, and the Nong Sarai FMD laboratory in Thailand are perhaps the two major FMD laboratories in Asia.

One of the recommendations of the FAO/APHCA Working Group on FMD in Asia and the Pacific Region was to elevate these two laboratories to Regional Reference Laboratories (FAO/APHCA Report, 1984). In September, 1985, FAO recognized the Nong Sarai Laboratory as FAO Regional Reference Laboratory of FMD for South-east Asia and the Pacific.

At the IVRI, Bangalore a micro CFT to determine the quantity of CF antigen and a double sandwich micro ELISA test to estimate the 146 S content in viral harvests have been introduced. For the evaluation of antibody response following vaccination in cattle and pigs a semi-automated microneutralization test employing BHK_{21} and IB-RS-2 cell systems, respectively, are in use. Research into adoption and application of recombinant DNA technique and the production of monoclonal antibodies for FMD virus is in progress (Rao, 1986). The incorporation of the latest laboratory techniques for diagnosis and vaccine production should provide a much better laboratory supporting service for the control of the disease in India and in the Region in the nineties.

The setting up of diagnostic laboratory facilities in Nepal and Burma, and the strengthening of facilities in Pakistan, Bangladesh, Sri Lanka, and the Philippines should provide the reliable epidemiological information for the implementation of their respective control programmes in the nineties.

FMD vaccine production facilities are present in a number of countries in Asia, viz, Iran, Pakistan, India, Bangladesh, Sri Lanka, Thailand, and Indonesia. The production capacities in all these countries are much higher than actual current production, mainly because vaccine demands have been low. With the initiation of vaccination programmes for the creation of DFZ in the nineties, this situation will change. The existing vaccine production plants will be able to cope with the expected increase.

Suspension BHK_{21} cell cultures in fermentor tanks are the common means of producing FMD vaccines in Asia; however, there are a few countries still using roller bottles. For production of larger volumes these countries would have to convert to fermentor tanks. Inactivation of virus is in some cases still being carried out by formalin. Binary ethyleneimine (BEI) inactivation developed by the Pan-American Foot-and-Mouth Disease Centre (PAFMDC) in Rio de Janeiro, Brazil has proved easier and safer to handle than acetylethyleneimine (AEI) and a more reliable method of inactivation than formalin. Moreover the chemicals needed for BEI inactivation can be obtained more readily and cheaply and the likelihood of residual infectivity of the vaccine with formalin inactivation is eliminated. The use of BEI as a inactivant is limited to one or two vaccine production facilities in the region. It is hoped that in the nineties, countries producing FMD vaccines will discontinue the use of formalin as an inactivant and use one of the arizidine derivatives such as AEI or BEI.

Vaccine adjuvant is another area for improvement. The commonly used adjuvants for ruminant FMD vaccine are aluminium hydroxide and saponin. A small portion of oil adjuvant vaccine (OAV) for pigs is produced. The success achieved by the use of OAV for ruminants in South America is a significant advance. The OAV produced by PAFMDC, is a water-in-mineral oil emulsion vaccine which protects cattle for much longer periods than the aluminium hydroxide-saponin vaccines. Besides, after revaccination, the OAV induce a prolonged solid protection. It is suitable also for swine. The use of OAV will eliminate the need for three and even two vaccinations per year as is being practised now with alum precipitated vaccines.

Quality control of FMD vaccine is of the utmost importance for the success of any control and eradication programme. This has not received the attention it warrants. In South America, it was found that the use of better quality vaccines under well defined and controlled conditions resulted in better acceptance of vaccination programmes and a highly significant reduction in outbreaks. In the absence of a central agency for Asia to set the standards and monitor quality of vaccines, it now rests upon individual government authorities to ensure this. A central agency for Asia may not be realised by the nineties but there is definitely a possibility for the vaccine producing nations in Asia to meet and arrive at common standardization and evaluation procedures. This will certainly give a boost to the APHCA-sponsored Vaccine Bank as recipient countries would be ensured of the quality.

The evaluation of vaccination programmes is an area that has largely been neglected. It is only when problems with "vaccine breakdowns" occur that an evaluation is contemplated. Vaccine evaluation for potency, adequate antibody response in vaccinated animals, frequency and interval between vaccination, susceptible species to be vaccinated in a given area, coverage required and achieved, delivery, transportation and cold-chain requirements, and many other aspects of a properly planned vaccination

programme need to be looked into before and during a campaign.

The FMD control campaigns in several countries in Asia, have not yet resulted in a solid herd immunity mainly because of the strategy of limited vaccination. This may cause the development of virus strains with different antigenic characteristics. Consequently, to ensure effectiveness of the vaccine in the field, a well functioning monitoring system is needed to determine whether emerging strains are still covered by the immunogenic characteristics of the vaccine strains. Thus in Malaysia, during the O_1 and Asia-1 outbreaks in 1980 and 1985 respectively, the potency of imported vaccines used in Malaysia were tested by challenge trials and serological tests in collaboration with the World Reference Laboratory for FMD at Pirbright, U.K. The results of these evaluation studies indicated the need, for Malaysia at least, to incorporate the local outbreak strains along with the international vaccine strains in the imported vaccines. Similar studies have been carried out in India and Indonesia. The successful simultaneous FMD and haemorrhagic septicaemia vaccinations has reduced the number of times animals need to be mustered as well as increase the number of animals vaccinated against FMD (Joseph and Hedger, 1984). For Asia, a combined Pasteurella multocida B : 6 and FMD virus OAV vaccine will be of great value for the control of both haemorrhagic septicaemia and FMD.

The importance of virus surveillance in the field cannot be overemphasised. Many countries do not train their field personnel to submit specimens periodically from recurring outbreaks and from all instances where vaccine "breaks" have occurred. A better coordinated field surveillance system should be built if the various control programmes scheduled to take off in the coming years are to meet with success. This is a priority area for the nineties.

The proper storage and distribution of FMD vaccine are of major concern. Frequently the end user or the person handling the vaccine at the end of the chain is not aware of the paramount importance of maintaining the cold-chain. The OAV offers distinct advantages in this regard. The work being done at IVRI, Bangalore in freeze-drying live and inactivated FMD viruses (Rao, 1986) is of interest here as freeze-dried vaccines lend themselves better to storage under tropical conditions.

Most countries in Asia where FMD is endemic have some form of control or are at least planning for control. These countries, however, need to have a national plan with the full commitment of the respective governments. Half-hearted measures without such a national policy and strategy is pointless. In Europe the increased application of systematic vaccination, complemented by severe restrictions on animal movements from infected areas (later from infected countries) enabled the disease incidence to be reduced to a level where eradication could be attempted by combining vaccination with slaughter and so interrupting the various cycle of alternating periods of disease recrudescence.

The characteristics and cattle-raising techniques in extensive regions of Asia differ from those existing in other more developed countries that have been able to eradicate FMD. Although intensive livestock management practices do exist in some Asian countries, the overall production system is usually extensive and it is common and frequent to move animals over long distances. In several countries "livestock markets" are the main marketing outlets. Borders between countries are frequently extensive and difficult to control. These characteristics are responsible for the necessity of maintaining regular massive and systematic programmes, which by themselves alone, will probably not suffice to eliminate the disease. It must be emphasized that no matter how great the bovine populations' immunological cover is, the existence of FMD endemic areas in some regions of the Indian sub-continent or the South-east Asian mainland, place the livestock in those countries under permanent risk of disseminating the disease. That risk is magnified whenever there occur natural upheavels (floods, droughts) festivals, virological (virus strain) modifications or price fluctations (domestic and international prices), that favour epidemic occurrence of FMD.

As a matter of policy the countries in Asia should, in the nineties, move towards:

a. Preservation of the existing disease-free areas;

b. Eradication of the disease from Sri Lanka, Peninsular Malaysia, and Philippines; and,

c. Establishment of disease-free zones in S. India, S. Thailand, Pakistan, Nepal, Bhutan, Burma, and Vietnam.

The South American Commission for the Control of Foot-and-Mouth Disease (COSALFA) has spelled out the policy and strategies for the control of foot-and-mouth disease in South America in the ten-year period 1981-1990 (COSALFA Report, 1981). The following strategies adopted by the South American countries are equally applicable to us in Asia if we are to achieve the objectives stated above.

a. Consolidation and expansion of unaffected and free areas through the application of prevention and eradication strategies corresponding to free areas.

b. Elimination of the disease in sporadic areas, by gradually replacing massive and systematic vaccinations with other preventive measures, including intensification of active surveillance and stategic or emergency vaccination.

c. Elimination of the endemic areas as sources of the infection, through the combination of action for a solid immunological cover of the bovine population (with priority utilization of vaccines having greater immunological efficacy) and strict control of outbound animals.

d. Reduction of the risks of the disease in the remaining areas, through a combination of the strategy used in endemic areas with massive and systematic vaccination of the herds being fattened out (moved for fattening), control of incoming cattle and the timely elimination of outbreaks.

In the last decade there have been a number of attempts at regional co-operation in the matter of FMD. Most of these attempts have been confined to the information and training sectors. No implementation of actual control strategies and programmes has taken place, other than the APHCA sponsored Vaccine Bank and the recent elevation of the Nong Sarai FMD laboratory to the level of an FAO Regional Reference Laboratory. There has been some sharing of information on outbreaks and virus type and subtypes but if such information is going to be of any help then it has to be regular, and provide an early warning to neighbouring countries.

There have been a number of instances of successful bilateral programmes in Asia. The Australian assistance to Indonesia from 1975 to 1981 is a good example of the success that can be achieved. Similarly, Japan, and Thailand collaborate in the field of diagnosis and vaccine production. FAO has provided assistance to a number of countries.

ASEAN and the newly inaugurated association of South Asian States could probably set up committee to co-ordinate FMD control in their respective regions. APHCA has a much wider influence with 14 countries in Asia as members and many others likely to join. APHCA has so far provided the leadership in FMD control in Asia. The nineties could perhaps see the creation of a specific commission for the control of FMD in Asia, somewhat on the same lines as the European Commission or the South American Commission (COSALFA).

The nineties would be a crucial period for foot-and-mouth disease control in Asia. We can progress on the substantial gains that have been made in the last decade or lapse into mediocrity and half-hearted approaches. It is our problem and it will be up to us to find the right solutions. Third country assistance and co-operation from international agencies would be forthcoming if the sovereign nations in Asia commit, plan and implement national policy and strategies for control with regional characteristics.

Foreign Animal Disease Update

Foot-and-Mouth Disease (FMD). Chile reported the confirmation of FMD type O_1 on March 12, 1987. To date, 19 separate outbreaks have been recognized. A total of 4,206 animals have been sacrificed. Movement of animals into Chile from Argentina is suspected as the cause of the outbreaks. Control measures adopted by Chilean animal health officials include epidemiological investigations, quarantine, stamping out, and disinfection of affected premises. Chile's last outbreak of FMD was reported in May 1984.

Italy's FMD situation is reportedly worse than it has been during the past 2 years. After a relatively calm December 1986,

11 outbreaks were reported in January 1987, 52 outbreaks in February, and 58 outbreaks in March 1987 up to the 23rd day of the month. These represent the highest number of outbreaks recorded since the previous peak in the winter of 1984-85. The disease has also spread into previously unaffected locations, including some areas in southern Italy. All of the outbreaks mentioned have been confirmed as FMD type A_5.

In Israel, an FMD outbreak was reported in sheep. Two neighboring commercial flocks of nonvaccinated sheep were affected, comprising 50 and 25 animals respectively. A total of 20 animals were reported to be clinically affected and 3 deaths were reported. Clinical and laboratory confirmation of FMD type O was performed by the Kimron Veterinary Institute. Quarantine of the affected village was initiated and animal movement in the entire district was restricted. Vaccination and revaccination in the controlled area of Samaria has been instituted.

In Asia, Hong Kong reported 2 outbreaks of FMD for December 1986 and 1 for November 1986. Type O virus was isolated from 3 samples from Hong Kong at the Pirbright World FMD Reference Laboratory. In addition, Pirbright reported the confirmation of types O and A FMD virus from Nepal, type A from Saudi Arabia, type O from Bahrain and Sudan, Africa, and type A from Thailand and Cameroon.

African swine fever (ASF) has been reported from South Africa in the northwestern transvaal area. The last report of ASF for South Africa was in August of 1985. Italy continues to report ASF from Sardinia.

Contagious bovine pleuropneumonia (CBPP). Thirty-one (31) cattle were reported as infected at Sulaibiya, Kuwait. Namibia (South West Africa) reported 2 foci of CBPP for November of 1986 and 1 focus for January 1987. (Dr. James T. Cavanaugh, 301 436-8233)

Research at Plum Island

(Note: The following articles complete a series on foreign animal research at the Plum Island Animal Disease Center (PIADC), Agricultural Research Service (ARS), U.S. Department of Agriculture (USDA), Greenport, N.Y. The series began with 14-1.)

Immunological responses to African swine fever virus are being investigated in swine.

African swine fever virus (ASFV) infects cells of the monocyte-macrophage series. Methods have been developed for the purification of pig monocytes and their growth in cell culture using colony stimulating factors. The cultured monocytes retain full susceptibility to ASFV. The sequence of virus-induced cytopathogenic effect (CPE) in monocyte cultures begins with detection of viral antigen within normal appearing monocytes, followed by the attachment of pig red cells to infected monocytes (hemadsorption); rounding, enlargement and detachment of monocytes; formation of rounded cells into grapelike clusters; and, finally, cell lysis.

Peripheral blood of pigs infected with a moderately virulent strain of ASFV contained high titers of virus at 4-18 days post infection (DPI), which declined until no longer detectable at 40-50 DPI. More than 99 percent of the virus was associated with erythroctes, and the remaining 1 percent was found in plasma, monocyte, lymphocyte and granulocyte fractions. During the viremic phase, erythrocyte and total leucocyte numbers were maintained at or near normal values with minor changes in percentages of monocytes, lymphocytes and granulocytes. Mononuclear leucocytes (MNL) remained fully functional when tested by various procedures.

The serum of recovered pigs contained antibodies that could inhibit virus-induced CPE and virus production in cultures of normal pig monocytes. The immune sera were specific for the homologous ASFV strain, did not require complement, were effective only when used undiluted and were found in all recovered pigs tested (N=17). The sera were not specific for heterologous ASFV. Increasing levels of virus inhibitory antibodies were associated with declining viremia. These studies strongly indicate that antibodies are important in the protection of pigs against ASFV.

Cell mediated immunity (CMI) of infected pigs to ASFV antigens was detected at 11 DPI and persisted for more than 100 DPI. All 17 recovered pigs developed ASFV-specific CMI. Preliminary studies indicate that several ASFV antigens might be responsible for CMI.

The studies indicated that ASFV recovered pigs developed both humoral and cell mediated virus-specific immune responses with no evidence of immunosuppression. (R. C. Knudsen and E. V. Genovesi, PIADC, Greenport, N.Y.; 516 323-2500)

The ability to transmit foot-and-mouth disease virus (FMDV) via bovine embryos was tested in a series of five experiments:

1. Examination of embryos after in vitro exposure to FMDV.
2. Examination of embryos collected from FMD viremic cows.
3. Viral assays on reproductive tracts from FMD viremic cows.
4. Examination of embryos collected from FMD convalescent cows.
5. Implantation of embryos collected from FMD viremic cows.

The sanitary procedures used to process the embryos were those recommended by the International Embryo Transfer Society and adopted by the Office International des Epizooties (OIE).

In experiment 1, groups of 6-day embryos with intact zona pellucidas were exposed to FMDV for 4 and 18 hours and washed. One 4-hour and one 18-hour group was assayed immediately after washing. Two 18-hour exposed groups were incubated for an additional 24 and 48 hours. No virus was isolated by in vitro culture or animal inoculation from any of 169 embryos.

Groups of 11-day hatched embryos were exposed to FMDV for 2 hours and washed. One group was assayed immediately, one group was

incubated an additional 18 hours, and one group was incubated an additional 48 hours. FMDV was isolated from 14 of 52 hatched embryos.

In experiment 2, embryos were collected nonsurgically from 2 viremic cows and post-mortem from 7 viremic cows. No FMDV was isolated by culture or animal inoculation from 48 embryos developed from zona pellucida-intact ova.

In experiment 3, blood, vaginal swabs, uterine flush fluid, uterine sediment, ovaries, and follicular fluid were assayed for FMDV. FMDV was isolated from all of 18 blood samples, 18 vaginal swabs, and 18 ovarian samples. Titers were similar and the highest titer was 10^6. FMDV also was isolated from 12 of 16 uterine flush fluid samples, 8 of 13 uterine sediment samples, and 15 of 17 follicular fluid samples. The highest FMDV titer in uterine flush fluid and sediment samples was 10^2 and the highest titer in follicular fluid was $10^{4.4}$.

In experiment 4, 42 zona pellucida-intact embryos were collected from 21-day FMD convalescent cows. No FMDV was isolated by culture or animal inoculation.

In experiment 5, 26 normal-appearing embryos collected from 7 FMD viremic cows were implanted into 18 recipients. All the recipients remained clinically normal and were negative for FMD antibody 30 and 60 days after implantation. In addition to the normal embryos, 57 degenerating zona pellucida-intact ova were collected. These were processed and assayed by culture and animal inoculation. No FMDV was isolated. The large number of degenerating embryos was attributed to the high fever in the donors. (C. A. Mebus, J. W. McVicar, and P. D. McKercher, PIADC, Greenport, N.Y., and E. L. Singh and W. C. D. Hare, Agriculture Canada, Animal Disease Research Institute)

Alternate approaches to and improvements in conventional killed FMDV vaccines are being studied.

FMDV is characterized by a large number of serotypes and strains of the virus and a tendency to generate new strains by selection and mutation. Molecular studies of the viral genome are underway to find the basis for antigenic variability through sequence changes in the viral genome which specify the antigenic proteins of the virus. Antigens of the virus are being characterized using monoclonal antibody technology. Together, these methods are helping to establish the line between genome nucleic acid sequence and antigenic sites on the virus.

Alternate sources of FMDV antigens as vaccines are being investigated using segments of the viral protein VP-1 expressed in bacteria via recombinant DNA methods. (See 10-3). The presence of distinct antigenic sites is determined by selective expression of peptide sequences or by chemical synthesis of peptides. The synthesis and processing of FMDV protein in an *in vitro* protein synthesis system programmed with FMDV RNA has shown assembly of structures which appear to display "native" antigenic

(conformation) sites of FMDV particles. These findings are providing the basis for the cloning of engineered FMDV sequences into a vaccinia virus-vectored FMDV assembly system which may provide a source of potent FMDV antigens without the need to produce infectious FMDV. Also, the vaccine would be "live," requiring only inoculation of animals by "scarification" to effect an immunization.

The use of monoclonal probes, as an alternate FMD detection method to antigenic or infectious studies, is being evaluated for sensitivity, specificity, reliability and cost, as compared to present conventional methods. The detection of FMDV through hybridization detection of the viral RNA is being studied through ARS research funded in part by the Animal and Plant Health Inspection Service (APHIS). (D. M. Moore and D. O. Morgan, PIADC, Greenport, N.Y., 516 323-2500)

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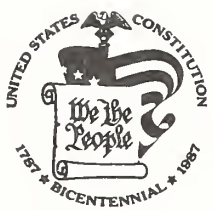

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